REMARKS

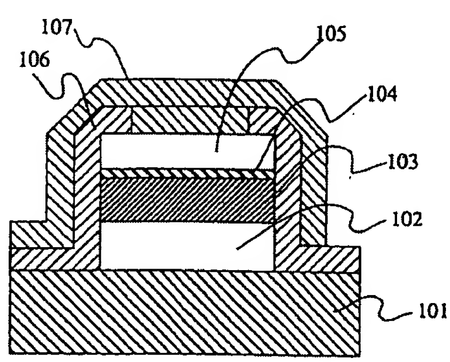
Novelty and Nonobviousness of Pending Claims

Claims 40-47, 52-55 and 63 were rejected under 35 U.S.C. §102(a) as being anticipated by Miki, et al. Applicants respectfully submit that Miki, et al. does not anticipate applicants' claimed invention.

Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, **arranged as in the claim.** *Lindermann Maschinenfabrik GMBH v. American Hoist and Derrick Co.*, 221 U.S.P.Q. 481, 485 (Fed. Cir. 1984) The Miki, et al. reference does not meet this standard.

As shown below, in Figure 1 from Miki, et al., the structure comprises an oxygen- containing layer **104** that separates the ferroelectric material layer **103** from the top electrode layer **105**.

FIG. 1



Layer **104** is described in multiple ways in the reference, and as such, there is no definitive statement in the reference to determine the exact composition or base material of layer **104** that separates the top electrode from the ferroelectric material film. For example, as stated in the Miki, et al. specification at column 4, lines 28-34, the layer is referred to a layer formed by annealing in an oxygen atmosphere to repair oxygen loss on the surface of the high-dielectric material when the upper electrode **105** was formed. As further stated at column 7, line 60 to column 8, line 2, the layer **104** is allegedly formed on the surface of the capacitor insulating film by a method other than

annealing in an oxygen atmosphere. Specifically, the Miki, et al. reference states that a deposition method "actively included oxygen in the upper electrode (in this case platinum)." Thus, the layer **104** is a layer with oxygen content but the base layer material is unclear.

By contrast, the present invention shows a microelectronic device comprising a pure metal top electrode directly deposited and contacting a ferroelectric material film as shown in Figures 1 and 2, recreated below for ease of reference. Figure 1 shows a thin ferroelectric material layer **12** between electrodes **14** and **16** of a capacitor. The ferroelectric material layer **12** may be formed of PZT, BST or SBT, deposited on the bottom electrode plate **16** by a suitable process such as CVD. The top electrode is formed of a pure metal, by sputtering in a manner consistent with the invention, to avoid depletion of the oxygen content of the surface region of the ferroelectric oxide film **12**. Importantly, the top surface and vicinity thereunder of the ferroelectric oxide film material is substantially stoichiometrically complete in oxygen concentration while the top electrode maintains it purity.

Figure 2 shows a capacitor **30** that comprises a top electrode **32**, and bottom electrode **34** on which is disposed a thin film ferroelectric material layer **36**, wherein the top surface and vicinity thereof of the ferroelectric material is substantially stoichiometrically complete in oxygen concentration. Notably, in both structures, the top electrode is not separated from the ferroelectric material layer by any additional layers. Thus, the structures of the present invention do not have a distinct and separate layer that is positioned between the top electrode and the ferroelectric material film.

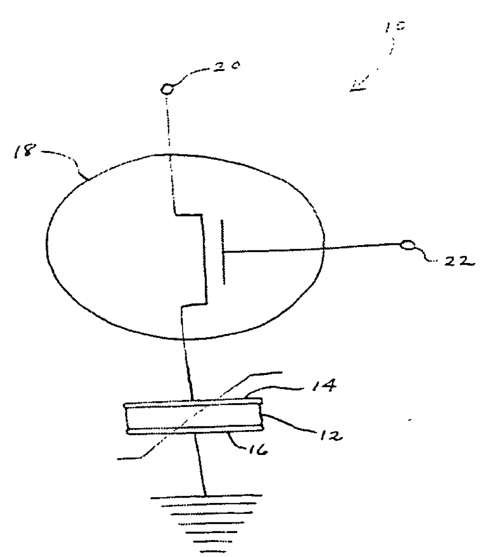


Figure 1

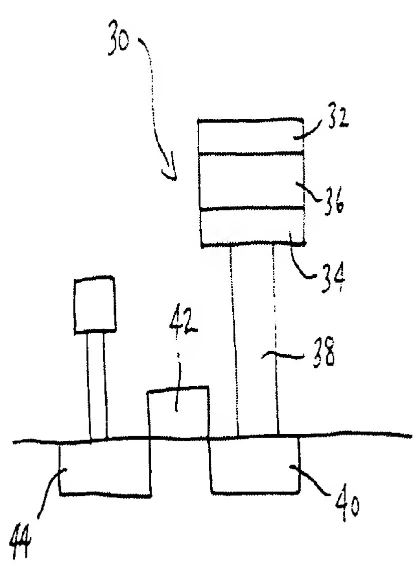


Figure 2

The specific disclosure of Miki, et al. relating to **104** layer and the exact composition of the interlayer between the top electrode and ferroelectric material layer is vague and uncertain to such an extent as to beg the question of whether the Miki, et al. reference is enabling because of the fundamental ambiguities in the reference. It is well established as a matter of law that before a reference can be prior art under section 102, a reference must be enabling and it must put the claimed invention in the hands of one skilled in the art. (*In re Sun*, 31 USPQ2d 1451 (Fed. Cir. 1993)). Further, an anticipation rejection cannot be predicated on an ambiguous reference (*In re Turlay*, 134 USPQ 355 (CCPA 1962)). A reference is good for only that which it clearly and definitely discloses. The fact that Miki, et al. explicitly teaches that the **104** layer is an insulating layer, while concurrently stating that oxygen is incorporated directly into the crystal structure of the platinum electrode introduces confusion as to what exactly is being disclosed in Miki, et al. It is well established in the law that if a reference is ambiguous and can be interpreted so that it may or may not constitute an anticipation of an applicant's claim, an anticipation rejection under 35 U.S.C. §102 based upon the ambiguous reference is improper (*In re Hughes*, 145 USPQ 467 (CCPA 1965)). This is the current situation, and as such, Miki, et al. does not support an anticipation rejection.

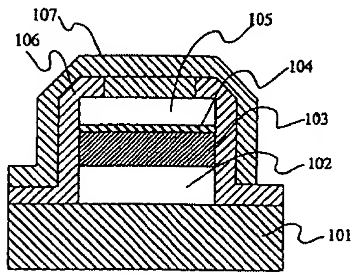
Further, the only electrode material discussed in the entire Miki, et al. reference relates to Pt which is considered to be the type of material that easily allows the diffusion of oxygen therethrough during a subsequence oxidative annealing process. Clearly the Miki, et al reference <u>does not identically disclose or describe</u> applicants' claimed invention as required of an anticipatory reference applied under section 102. (See *In re Felton*, 179 USPQ 295 (CCPA 1973)) Accordingly, applicants respectfully submit that claims 40-47, 52-54 and 63, as amended, are patentably distinguishable over Miki, et al. Withdrawal of this rejection under 35 U.S.C. §102(a) is requested.

<u>Rejection under 35 U.S.C. §103(a)</u>

In the April 14, 2004 Advisory Action the rejection of claims 49, 51 and 61 under 35 U.S.C. §103(a) was maintained based on a combination of Miki, et al. and Park, et al. Applicants submit that the introduction of Park, et al. does not overcome the shortcomings of Miki ,et al., and thus, the combination of the cited references does not in any way render applicants' claimed invention *prima facie* obvious.

As discussed above, Miki, et al, describes a structure as shown below in Figure 1, recreated from the Miki, et al reference, that includes a layer of oxygen containing material **104** positioned between the top electrode **105** and the ferroelectric material layer **103**.

FIG. 1



Layer **104** is described in multiple ways in the reference, and as such, there is no definitive statement in the reference to determine the exact composition or base material of layer **104** that separates the top electrode from the ferroelectric material film. For example, as stated in the Miki, et al. specification at column 4, lines 28-34, the **104** layer is referred to as a layer formed by annealing in an oxygen atmosphere to repair oxygen loss on the surface of the high-dielectric material when the upper electrode **105** was formed. In the alternative, as stated at column 7, line 60 to column 8, line 2, the layer **104** is allegedly formed by a method other than annealing in an oxygen atmosphere. Specifically, the Miki, et al. reference states that a deposition method "actively included oxygen in the upper electrode (in this case platinum)." (See column 7, line 66 to column 8, line 2 of Miki, et al.) Thus, the layer **104** is a layer with oxygen content but it is unclear whether the electrode material has incorporated the oxygen or the dielectric material has incorporated the oxygen. Furthermore, if in fact the upper electrode is deposited in the presence of oxygen, the discussion in column 8, lines 10-14 of Miki, et al. clearly states that the platinum film "comprises microparticles and loses practically all of its orientation in the (111) direction. In other words crystal properties are extremely poor." Thus, it is quite evident that the top electrode material of Miki, et al. incorporates the oxygen and the dielectric layer is still lacking in oxygen content. This is just one more instance that clearly shows the differences between Miki, et al. structures and those of the presently claimed invention, that require the dielectric layer to be substantially stoichiometrically complete in oxygen concentration.

The presently claimed invention provides for a microelectronic device comprising a top electrode directly deposited and contacting a ferroelectric material film. As shown in Figure 1 of the present specification, the presently claimed device includes a thin ferroelectric material layer **12** between electrodes **14** and **16** of a capacitor. The ferroelectric material layer **12** may be formed of PZT,

BST or SBT, deposited on the bottom electrode plate **16** by a suitable process such as CVD. The top electrode is formed of Ir, IrO_2, Rd, or RdO_2, by sputtering in a manner consistent with the invention, to avoid depletion of the oxygen content of the top surface region and thereunder of the ferroelectric oxide film **12**. Importantly, the top surface and vicinity thereunder within the ferroelectric oxide film material is substantially stoichiometrically complete in oxygen concentration .

It is noted by the Office that Miki, et al. only describes a top electrode of platinum and to overcome the shortcomings of Miki, et al. the Office has attempted to combine the teachings of Miki, et al. and Park, et al. However, this proposed combination does not render applicants' claimed invention *prima facie* obvious.

Park, et al. describes a capacitor that prevents diffusion of oxygen from a dielectric layer by providing a barrier layer comprising refractory metal and grain boundary filling material. The barrier layer can reduce and preferably prevent diffusion of oxygen therethrough, and thereby reduce the leakage current and oxidation of the integrated circuit capacitor. The barrier layer, which is the gist of the Park, et al. disclosure, is deposited beneath the lower electrode. Park, et al. describes the use of Ir, Ru or oxides thereof for use of the bottom electrodes but further states that these materials used for electrodes have the same work function similar to the high dielectric material which causes inferior leakage current characteristics. As such the leakage characteristics must be compensated for by either thinning the electrode, introducing a sacrificial layer for reducing oxygen flow from the electrode to the barrier layer, or providing a barrier layer comprising refractory metal and grain boundary filling material.

It should be noted that there is no disclosure in the Park, et al. reference that discusses the process steps required for depositing a top electrode on the dielectric material. Further the reference is completely silent regarding the inherent problems related to deposition of the top electrode and the deoxygenation of the dielectric layer during this electrode formation step. Still further, the reference is completely silent regarding any additional annealing step that may be required to compensate for the loss of oxygen in the dielectric layer during the formation of the top electrode. Clearly, the Park, et al. reference does not recognize the problems associated with deposition of top electrodes and the concomitant loss of oxygen in the dielectric material that creates the need for subsequent annealing of the device under oxidizing conditions as described in Miki, et al.

Applicants question why one skilled in the art would combine the teachings of Miki, et al. with that of Park, et al. in an attempt to recreate applicants' claimed invention especially in light of the fact that Park, et al. never discusses or recognizes the problems of oxygen deficiency in the dielectric layer. Further, Park, et al. only mentions platinum group electrodes but does not provide any suggestion that one element of the group provides any additional benefits over that of the other members of the platinum group. Park, et al. used Ru as an electrode only in terms of a bottom sacrificial layer that upon further processing under an oxygen treatment forms RuO_2. As such the oxygen is incorporated into the electrode structure. (See column 2, lines 51-54 of Park, et al.). This is not unlike Miki, et al. that also incorporates oxygen into the platinum electrode as discussed above. However, the combination still does not teach, suggest or describe a dielectric layer that is substantially stoichiometrically complete in oxygen concentration as claimed by applicants.

Applicants further submit that the Office has failed to give weight to the advantages and benefits of the present invention in considering the "invention as a whole" and that the Office has cited references that do not disclose or teach such advantages or benefits. Applicants note that for some metals used in the deposition of electrodes the use of postdeposition annealing may be acceptable because the top electrodes will allow oxygen to diffuse therethrough to replenish the oxygen content of the underlying dielectric layer. However, this method is not acceptable when using preferred materials such as Ir and IrO_2 because they are not good oxygen diffusion barriers. Thus, applicants recognized this shortcoming and the presently claimed invention allows for the deposition of the preferred top electrode material by depositing in an oxygen atmosphere, which replenishes the oxygen content to the upper surface of the ferroelectric oxide layer. Moreover, applicants found that electrodes formed by sputtering at sufficient pressure, temperature and rate of deposition did not incorporate oxygen into the crystal structure of the electrode material, and as such, the electrodes exhibit lower compressive stress characteristics than those sputtered in the presence of oxygen where oxygen is incorporated in the electrode film. These lower compressive stress electrodes are desirable to facilitate the subsequent fabrication of additional layers and or to enhance the end-use device characteristics of the structure. Obviously, the cited references do not recognize these benefits of the present invention.

The Office must be cognizant of the fact that the Board and the Federal Circuit has reiterated numerous times that obviousness cannot be established by combining the teachings of the cited references to produce the claimed invention, absent some teaching or suggestion supporting the

combination and suggesting the desirability of the combination. The Office should be aware that the Federal Circuit recently addressed the question whether there is a reason to combine references and what is required by the examiner to show a suggestion to combine references and stated: (See *In re Lee*, 61 USPQ3d 1430, 1433 (Fed. Cir. 2002))

> "'The factual inquiry whether to combine references must be thorough and searching.' *Id.* It must be based on **objective evidence of record**. This precedent has been reinforced in myriad decisions, and **cannot** be dispensed with. *See, e.g., Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1124-25, 56 USPQ2d 1456, 1459 (Fed. Cir. 2000) ("a showing of a suggestion, teaching, or motivation to combine the prior art references is an `essential component of an obviousness holding'") (quoting *C.R. Bard, Inc., v. M3 Systems, Inc.*, 157 F.3d 1340, 1352, 48 USPQ2d 1225,1232 (Fed. Cir. 1998)); *In re Dembiczak*, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-**based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references.**"); *In re Dance*, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998) (there must be some motivation, **suggestion,** or teaching of **the desirability** of making the specific combination that was made by the applicant); *In re Fine*, 837 F.2d 1071, 1075, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988) ("`teachings of references can be combined *only* if there is some suggestion or incentive to do so.'") (emphasis in original) (quoting *ACS Hosp. Sys., Inc. v. Montefiore Hosp.*, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984)).
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> **The need for specificity pervades this authority.** *See, e.g., In re Kotzab*, 217 F.3d 1365, 1371, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000) ("particular findings must be made as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected **these components for combination in the manner claimed**"); *In re Rouffet*, 149 F.3d 1350, 1359, 47 USPQ2d 1453, 1459 (Fed. Cir. 1998) ("even when the level of skill in the art is high, the Board must identify specifically the principle, known to one of ordinary skill, that suggests the claimed combination.
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> In other words, the Board must explain the reasons one of ordinary skill in the art would have been motivated to select the references and to combine them to render the claimed invention obvious."); *In re Fritch*, 972 F.2d 1260, 1265, 23 USPQ2d 1780, 1783 (Fed. Cir. 1992) (the examiner can satisfy the burden of showing obviousness of the combination **"only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references**")." (Emphasis added)

Reading the above ruling, it is apparent that the Federal Circuit in 2002 has raised the bar that the Office must meet to show a suggestion or motivation to combine references to establish a *prima facie* case of obviousness. Applicants submit that the Office has not met the current standard set forth by the Federal Circuit to show a suggestion or motivation to combine the cited references and has not identified any objective or specific teachings or suggestion in the cited references that would motivate one skilled in the art to combine the two references. Thus, the Office seems to be merely reinterpreting the prior art in light of applicants' disclosure, in order to reconstruct applicants' claimed invention, but without any instructional or motivating basis in the references

themselves. Such approach is improper and legally insufficient to establish any *prima facie* case of obviousness. Accordingly, the rejection of claims 49, 51 and 61 must be withdrawn.

CONCLUSION

Applicants have satisfied the requirements for patentability. All pending claims are free of the art and fully comply with the requirements of 35 U.S.C. §112. It therefore is requested that Examiner Hu reconsider the patentability of the pending claims, in light of the distinguishing remarks herein, and withdraw all rejections, thereby placing the application in condition for allowance. Notice of the same is earnestly solicited. In the event that any issues remain, Examiner Hu is requested to contact the undersigned attorney at (919) 419-9350 to resolve same.

Respectfully submitted,

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